Conventional methods of measuring AOD can exaggerate the darkness by a factor of 2 or 3, but Dubey has corrected that error by deploying the world's first aircraft-mounted, three-laser, photoacoustic instrument. As a plane flies through clouds and haze, the instrument sucks in particles and exposes them to light from red, green, and blue lasers that together represent the solar spectrum. When particles absorb the laser energy and heat up, they expand the air around them and create a sound wave that is detected by a highly sensitive microphone. Sensors also detect light reflected by the particles. The two measurements together translate into an accurate measurement of AOD.

Dubey has flown over Mexico City, Korea, Houston, California, and even the Arctic to collect and analyze aerosol mixtures with the laser instrument. In Mexico City, he measured the effects of megacity pollution on global warming. In addition to finding sulfates and other kinds of aerosols he anticipated, he also detected a significant amount of aerosols produced by organic gases that vehicles emit. When the sun rises, these gas molecules undergo a photochemical reaction that turns them into particles dubbed "secondary organic aerosols." They were considered to be negligible, but climate modelers are now including them in chemical-transport simulations.

In Jeju, an island off the coast of South Korea and downwind from China, Dubey analyzed aerosols blowing in from Beijing to see if China had taken effective steps to clean the air for the 2008 Olympics. The Chinese government would not allow soot measurements within their country, but wind ignores borders, so Jeju was the next best thing.

But perhaps the most interesting of Dubey's observations were those obtained in the Arctic because they threw a new twist into the aerosol story. "You expect the Arctic to be pristine," says Dubey, "but it's pretty polluted." And the pollution isn't from local particles, as in Mexico City, but from an international mix of junk from all over the Northern Hemisphere. Dubey observed plumes similar to Los Angeles smog coming from Siberian fires, Gobi Desert dust storms, and industrial emissions. The new twist in the story is that the gray mix of aerosols, which contains a lot of black carbon, affects not just the atmosphere but also the ice itself. The aerosols settle on the Arctic ice sheet, causing it to absorb solar radiation and melt faster than computer models have predicted. Clean Arctic ice normally has a cooling, "albedo" effect, reflecting solar radiation.

A closer look at radiative forcing helps illustrate the significance of this phenomenon. Radiative forcing is expressed in watts per square meter (W/m2). If a climatic influence warms the planet, as greenhouse gases do, it causes positive forcing. If it cools, as do sulfate aerosols, it causes negative forcing. Over the last century, human-caused greenhouse gases have produced a positive radiative forcing of 2.6 W/m2 while aerosols are estimated to have had a negative radiative forcing of –1.2 W/m2, though that figure is still highly uncertain. These measurements are global, long-term averages that don't take regional and seasonal effects into account. Those are the very effects that current ice-melt models lack. During the period Dubey studied the Arctic, the radiative forcing of black carbon for that region was a whopping 30 W/m2.

"It's a double whammy," says Dubey. "Black carbon takes away the negative forcing of ice albedo and adds positive forcing directly to the ice surface." And it couldn't happen in a worse place.

In some places, regional and temporary disturbances might not impact global climate, but the Arctic isn't one of those places. Petr Chylek, a pioneer in aerosol science and a frequent collaborator with Dubey, explains why: "If global warming occurs, what disaster awaits humankind? Temperatures rose 0.7°C over the last 125 years, but you can't feel it. If it goes up another degree here, nothing happens. The danger is in the Arctic because melting Arctic ice results in rising sea levels. If the Greenland ice sheet melts, we have a global disaster."